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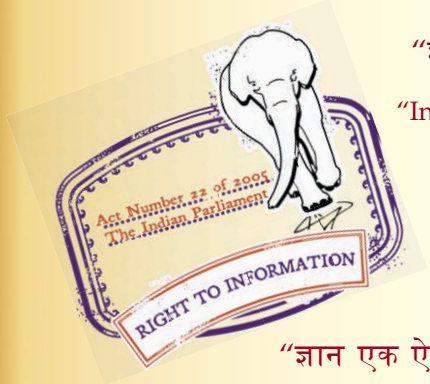

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METHODS OF TEST FOR VULCANIZED RUBBERS

PART XII TEAR STRENGTH — CRESCENT TEST PIECE

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METHODS OF TEST FOR VULCANIZED RUBBERS

PART XII TEAR STRENGTH — CRESCENT TEST PIECE

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Indian Standard

METHODS OF TEST FOR VULCANIZED RUBBERS

PART XII TEAR STRENGTH—CRESCENT TEST PIECE

0. FOREWORD

0.1 This Indian Standard (Part XII) was adopted by the Indian Standards Institution on 27 November 1971, after the draft finalized by the Rubber Products Sectional Committee had been approved by the Chemical Division Council.

0.2 The tear strength depends on the dimension of the test piece, speed of stretching, temperature of test and the stress distribution in the test piece; hence the test is satisfactory only for laboratory comparison and not as a service test. The tear strength is particularly susceptible to grain effects in vulcanized rubber. Where an estimate of service behaviour is desired, service trials on actual article should be carried out.

0.3 Method of test for angular and delft test piece shall be included in separate standards.

0.4 In the formulation of this standard, considerable assistance has been derived from the following:

ISO/R 34 Determination of tear strength of vulcanized natural and synthetic rubbers (crescent test piece). International Organization for Standardization.

BS 903 : Part A3 : 1956 Determination of tear strength. British Standards Institution.

0.5 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

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1. SCOPE

1.1 This standard (Part XII) prescribes the methods for the determination of tear strength of vulcanized natural and synthetic rubbers employing a crescent test piece.

*Rules for rounding off numerical values (*revised*).

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definition shall apply.

2.1 Tear Strength — The force required to cause a nick cut in a rubber test piece to extend by the tearing of the rubber, acting substantially parallel to the major axis or normal to the plane of the cut.

3. OUTLINE OF THE METHOD

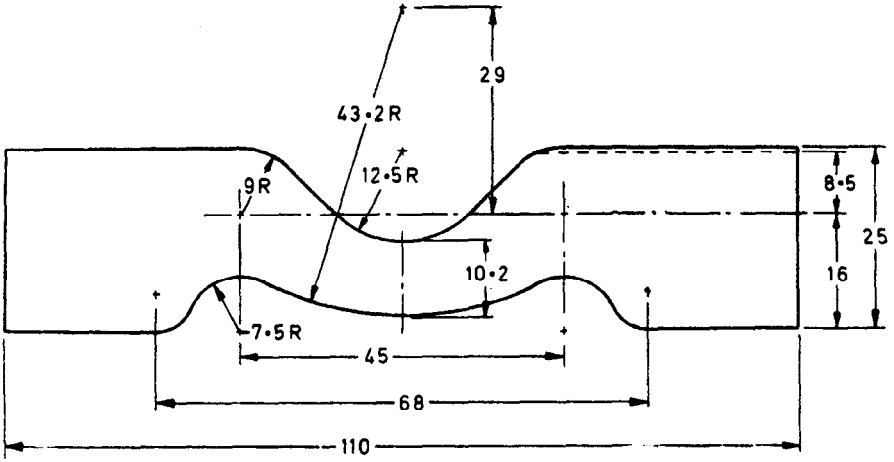
3.1 The test consists of cutting a slit of accurate depth in a special test piece and measuring the force required to tear across the width of the uncut portion.

3.2 The choice of a method for determining tear strength can at present be based only on considerations of reproducibility of the test results and ease of carrying out the test; the crescent tear described in this method will fulfil these requirements if the precautions specified are observed.

4. APPARATUS

4.1 Dies — The dies used for punching test pieces shall have the dimensions as shown in Fig. 1.

NOTE — The dies shall be carefully maintained so that the cutting edges are sharp and free from nicks to avoid leaving ragged edges on the test pieces.



All dimensions in millimetres.

FIG. 1 CRESCENT TEST PIECES

4.1.1 The test piece shall be clamped firmly in a vertical plane, especially in the region where the nick is introduced. The cutting shall be done by means of a razor blade clamped in a vertical plane at right angles to the test piece. The blade holder or the clamped test piece shall be mounted on guide rails which ensures an exact horizontal motion without any lateral movement and also exact centering of the nick. The cutter shall be fitted with a micrometer gauge for controlling the depth of the nick. The blade shall be wetted with water or soap solution during nicking.

4.2 Micrometer Dial Gauge — The instrument for measuring the thickness of tear test pieces shall consist of a micrometer dial gauge firmly held in a rigid stand over a flat base plate of diameter at least 50 mm. The gauge shall have a scale graduated in unit divisions of 0·01 mm. The dial gauge shall be fitted with a flat contact, square to the plunger and parallel to the base plate, and shall operate with a pressure of $0{\cdot}2 \pm 0{\cdot}03$ kgf/cm^2 (20 ± 3KN/m^2).

NOTE — It is preferable for the gauge to have a contact area of diameter about 4 mm as this may be used on almost all test pieces without any sub-part of the contact area overhanging the test piece edge, which would increase the contact pressure.

4.3 Measuring Instrument — For measuring the depth of the nick an optical instrument shall be used, the test piece being mounted so that the nick is slightly opened in order to make it visible.

4.3.1 When it is only necessary to check that the depth of the nick is within the specified limits, any suitable means may be used, for example, an optical projection apparatus. A convenient arrangement is a microscope giving about 100 × magnification and fitted with travelling stage suitably illuminated. The eyepiece is fitted with a graticule by which to record the travel of the stage and test piece through a distance equal to the depth of the nick. The travel of the stage is calibrated with a stage micrometer graticule.

4.3.2 Alternatively, a travelling microscope may be used. The apparatus shall allow an accuracy of measurement of at least 0·025 mm.

4.4 Tensile Testing Machine — The tensile testing machine shall be power driven and of such capacity that the maximum force required for the test is not greater than 85 percent nor less than 15 percent of the maximum of the scale. The rate of traverse of the driven grip shall be 500 ± 50 mm/min and the power shall be sufficient to maintain the rate substantially constant up to the maximum capacity of the machine. The machine shall be equipped to give a continuous indication of the force on the test piece during the uninterrupted stretching of the test piece. After the test piece has broken, the indicators shall remain at the point of maximum force. The machine shall be provided with a type of grip which tightens

automatically as the tension increases and exerts a uniform pressure across the widened end of the test piece. Each grip shall incorporate a positioning device so that all test pieces are inserted to a depth of 15 to 20 mm and are in axial alignment with the direction of pull.

NOTE — The force scale shall be calibrated by a suitable method at least every six months to ensure that the errror does not exceed 1·5 percent of the applied force or 0·3 percent of the maximum of the scale whichever is greater.

5. TEST PIECE

5.1 The test piece of the dimensions as shown in Fig. 1 shall be cut from the sheet by punching with a die using a single stroke of a press where the cut edge shall be normal to the surface. The rubber may be wetted with water or soap solution and shall be supported on a sheet of slightly yielding material (namely, leather or cardboard) on a flat rigid surface. Normally, all test pieces shall be prepared with grain at right angles to their length.

5.1.1 The thickness of the test piece shall be between 1·8 to 2·8 mm, but preferably 2·0 ± 0·2 mm, and shall be measured by means of micrometer gauge specified in **4.2**. The thickness in the region of the test area shall nowhere deviate by more than 2 percent from the mean.

5.1.2 A single nick or slit of 0·50 ± 0·08 mm depth shall be cut with extreme care and accuracy, symmetrically across the centre of the concave inner edge of the test piece. The variation between the nick depth on either side of the test piece shall not be more than 10 percent. Test pieces falling out of the tolerance specified for the nick shall be discarded.

6. TEMPERATURE OF TEST

6.1 Carry out the test at 27 ± 2°C unless otherwise specified. Some synthetic rubbers have markedly lower tear strength at elevated temperatures and hence tests may also have to be carried out at higher temperature, 100°C being the useful temperature.

7. PROCEDURE

7.1 Test at least three, but preferably six, test pieces.

7.2 Preparation of the Sample — If a fabric is attached or embodied in the rubber sample, remove the same before cutting the test pieces. Avoid preferably the use of a swelling agent while removing the fabric, but benzene; chloroform or carbon tetrachloride may be used to wet the contacting surfaces, if necessary. Take care to avoid stretching of the rubber during the separation from the fabric, and if swelling liquid is used, allow the same to evaporate completely from the rubber surfaces

after separation. Make the cloth marked surfaces smooth by buffing. Buff as and when necessary the rubber sample of uneven thickness, or of thickness above the maximum specified for the test piece which is to be cut from it. During buffing avoid undue heating of the rubber.

7.3 Conditioning of Test Pieces — The properties of vulcanized rubbers change continuously with time, these changes being particularly rapid during the first 24 hours after vulcanization. Do not carry out any test during this period; for accurate comparison between different rubbers it may be necessary to ensure that these are tested at substantially the same interval after vulcanization. Protect test pieces as far as possible from light. Condition samples after any necessary preparation at the test temperature for not less than 16 hours immediately before testing.

7.4 Nicking the Test Piece — Nick the test piece during the conditioning period, preferably towards the end of the period.

7.5 Measurement of Test Pieces — Four measurements of thickness in the region of the test arc shall be made and the average value shall be used in the formula given in **8**.

NOTE — The depth of the nick on both sides of the test piece shall be measured and the average value calculated. Any test piece in which the depth of the nick on either side is outside the limits stated above shall be discarded. The effective width of the test piece shall be taken as the minimum width of the die (10·5 mm) minus the average depth of the nick.

7.6 Determination of Tear Strength — Insert the test piece in the grips of the tensile testing machine, taking care to adjust it symmetrically so that tearing shall proceed in a plane normal to the direction of pull. Then start the machine and do not stop until the test piece breaks. Note the maximum load reached during the tearing along with the average thickness of the specimen.

8. CALCULATION

8.1 The tear strength depends upon the width and thickness of the test piece and the result is expressed as the force (in kilogram force) necessary to tear a test piece of standard width and thickness.

$$F = \frac{L \times W_1 \times t_1}{W_2 \times t_2}$$

where

L = breaking load in kgf,

W_1 = effective width in mm of standard test piece (9·7 mm),

W_2 = effective width in mm of actual test piece,

t_1 = thickness of standard test piece (2·5 mm), and

t_2 = thickness of actual test piece in mm.

9. REPORT

9.1 The report shall state:

a) the tear strength, as calculated in **8**;

b) direction in which test piece is cut relative to grain; and

c) temperature of test, if other than 27 ± 2° C.

NOTE — Where grain direction is not known, the conclusion drawn will be erroneous.

9.2 The result reported shall be the average of the middle two values, if an even number of test pieces is used, or the middle if an odd number is used, the various results being classified in the ascending order. If only three test pieces are used, the individual results shall be reported.

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